lines of adaptations which are not preëxistent in the germ plasma. We find that new characters of the second class do follow such purposive or directive lines, arising simultaneously in all parts of the organism, and first appearing in such minute form that we have no reason to suppose that they can be acted upon by selection. The old view of nature's choice between two single characters, one adaptive, the other not adaptive, must be abandoned, since the latter do not exist in the second class.

Fourth.—The most serious obstacle to the Lamarckian principle is the problem of transmission. How can peripheral influences be transmitted in the way we have outlined—now that we have such strong evidence for the continuity of the germ plasma? If acquired characters are not transmitted it is clear that the whole Lamarckian principle is undermined, and all these instances of sequence express no causal relationship. We are then, however, left without any adequate explanation of the laws of variations of the second class, and are thus driven to postulate some third, as yet unknown, factor in evolution to replace the Lamarckian principle.

METHODS AND MODELS IN GEOGRAPHIC TEACHING.[1]

BY WILLIAM M. DAVIS.

IN presenting to the Association certain considerations regarding methods of teaching geography, I venture to assume that your interests in educational matters extend so far down as to reach a subject which many scholars "finish" early in their course, and whose advanced study hardly receives its due place in our colleges; certainly it has suffered from neglect. My own practice in the way of teaching it has been with college students in the division of physical geography, and not feeling entirely satisfied with the system of study as presented in the text-books in current use, I have endeavored to discover and supply certain elements by which instruction in the subject might be advanced.

[1] A lecture delivered before the Scientific Association of Johns Hopkins University, on February 13, 1889.

The first element that should be supplied is one by which the conceptions which the teacher has in mind can be vividly transferred to the student. The teacher bases his mental pictures on something that he has seen, if he is so fortunate as to have traveled and brought home with him fresh memories of the morphology of the earth's surface; or if not an observer himself, he has at least had time to gain his geographic conceptions slowly, and with the aid of various descriptions and illustrations that he cannot present in their entirety to his class. How shall his ideas be passed on to his students? Maps and pictures are of value, but as a rule they are of low quality, except for the larger parts of the world. They present no sufficient expression of the forms of moderate size on which we live. Photographs are excellent as illustrations of actual landscapes, yet they are too often chosen with other than geographic reasons for the choice, and but few schools have them in sufficient variety. Moreover, all these aids lack one element of great value, namely, the third dimension that so strongly characterizes all geographic forms. I have therefore desired to use geographic models, which very easily give clear indication of the relief of a surface, and if without all its detail, still possess effective and suggestive form. Models are therefore to be taken as one of the means of improving the methods of illustrating what the teacher wishes to place before the class.

Again, physical geography as ordinarily defined is too largely merely descriptive, and not physical at all. Indeed, geography, which is supposed to treat of the form of the surface of the earth, neglects the form of the earth's surface to an unfortunate extent. We hear much about the connection between geography and history, for example; but what is this subject that is connected with history? Where is geography itself taught with the same thoroughness that characterizes the modern teaching of the biological sciences? We recognize of course the vital connection between geography and history, just as the botanist recognizes the connection between botany and medicine, but what botanist would be satisfied with stopping his teaching of his science or even of only its elements at the point that would suffice for the collector of medical herbs, or for the doctor of medicine? And

why should the geographer be satisfied with so brief an outline of his science as will suffice for illustrating its connection with history? The subject deserves study for its own worthy self; it is in this line that the teacher of geography must wish to see it developed, and it is to this end that he must strive, just as his colleagues strive to advance the study of their respective sciences for their own sake, and not merely for the illustration of some other. For this reason I have endeavored to examine the forms of the land surface in detail, and to arrange them in their genetic relations, in order to come to a closer appreciation of the meaning of the form of the earth and its development. In this way, it seems to me, we may best study the fundamental material of geography. A year ago I had the pleasure of presenting some outline of a geographic classification at a meeting of the National Geographic Society in Washington, and now I would add thereto some account of certain geographic models,[1] designed as a means of illustrating this classification. Some of the models illustrate the development of plains and plateaus; some present the various forms of volcanic cones and lava flows; others indicate the changes in the features of a river as it grows old, or as it is embarrassed by glacial or volcanic accidents. You will perceive, in considering the use of these models, that it is essential that we should study the surface of the land by means of types, for it would be as impossible for a scholar to learn all the individual forms of the land as it would for the young botanist to learn all the individual plants of the world, especially if they were brought before him in the order of their occurrence over the world, and not in accordance with some well-tried system of logical and natural classification. Botanists and zoölogists believe that it is time enough for their scholars to study the complex congeries of forms that constitute the fauna or flora of a country when they have mastered the rudiments of the subject by careful study of a moderate number of typical examples of plants or animals; and, indeed, in the modern development of

[1] The originals of these models were designed by me for use in a course of lectures before the Teachers' School of Science in Boston in 1888; copies of them have been prepared by Mr. J. H. Emerton, Boston Society of Natural History.

the study of biology, one may see the strongest contrast with the older methods in this respect. I should be glad to see a similar change overtake the conservative science to which my studies are devoted.

In order to give specific illustration of the method of study by geographical types and the use of models, let me ask your consideration of that large group of land-forms that may be included in the category of plains, plateaus, and other derivatives. There is a brief preliminary consideration.

Any mass of land constituting a single geographic individual or a natural group of such individuals, must, as soon as it is exposed to the destructive forces of the atmosphere, begin its long sequence of development; and if no change of level happen to it, it must at length be worn down smooth and low to a featureless plain. When this work begins, with every mark of immaturity in its small accomplishment, we may regard the individual as young; that is, but little advanced in the long cycle of systematic change through which it is destined to pass. When much more work has been accomplished, and the variety of form resulting is at its greatest, the individual may be called mature; and finally, when the features of maturity weaken as the relief is reduced and intensity of form is lost, we find a resemblance to organic decay, and are warranted in the use of such a term as old age.[1]

But you may say that all this is geology, not geography. Geological processes are indeed at work in carrying the geographic individual through its successive forms, but we are not concerned with the processes, only with the results. In organic growth, the process is chemical; but for all that, biology is not chemistry. Moreover, if the several forms assumed by a geographic individual are geological affairs, we might expect to find them treated in the standard works on that science, but, except in brief outline, nowhere do they appear in such books. Geology is quite enough occupied with matters of underground structure,

[1] The example of a form in its "old age," as that term is employed by Chamberlin and Salisbury (Sixth Ann. U. S. Geological Survey), would in the above scheme be called "mature," for it still possesses abundant relief, and is by no means a featureless base-level plain.

with questions of constructive and destructive processes, and with composition and fossil contents of rocks to be awake to another large question. The study of the form of the earth's surface, even though recognizing that the form changes, is geography. But after all, geography and geology are one science, treating of the earth, and it is needless for us to embarrass our work by attempting unnecessary subdivision and limitation of the fields that the two branches shall occupy. Let each one take whatever will aid its attainment of the desired end. If we can understand geographical morphology better by some consideration of geological structure, let it be introduced, just as chemistry is introduced into physiology, or physics into meteorology. Surely geologists have employed geographical methods freely enough to warrant our reversing the relation. If some consideration of geological processes will serve our purpose and give better appreciation of the sequence of forms that geographical individuals pass through, then call freely on geology for such consideration and use it to the best advantage. Do not hamper our endeavor to understand the form of the earth's surface by any arbitrary limitation of the means that we shall employ to the end. It is plainly apparent that geology and geography are parts of one great subject, as ancient and modern history are, and they must not be considered independently. Indeed, it is only in this close relation that a satisfactory definition of the two terrestrial sciences is obtained. Mackinder has concisely said that geology is the study of the past considered in the light of the present, and geography is the study of the present considered in the light of the past. I can quote no better indication of the close connection of the two divisions of the world's history. Without going further into abstract considerations, we may now turn to our concrete examples.

The so-called "valley" of the Red River of the North in Minnesota and Dakota is a broad plain of exceedingly level surface. It is so truly level that it illustrates the curvature of the earth, in the same way that it is seen at sea; for in crossing the plain first a distant tree-top is seen above the horizon, then a house-top, and at last the body of the house rises into full view; just as the upper and lower sails and the hull of a ship are

brought into sight in sailing towards it on the ocean. This broad plain is a lake bottom, whence the water in which its fine sediments were laid down has been drained away, and drained away by so curious a process that if, in teaching modern history, it were noted that some existing form of government were as curiously related to the past, no teacher would hesitate to make reference to it. The northern barrier that held the waters of the lake was the southward front-slope of a great sheet of ice that for a time obstructed the open northward drainage; and in the lake thus created fine sediments were spread out so plentifully that they buried the former surface of the land, and so evenly that when the waters were drained away as the ice melted a dead-level plain was revealed.

The plain stands well above sea-level, and hence must suffer change as destructive processes attack it. Why then is it so smooth? Manifestly because it is young. There has not yet been time for streams to channel it. It is extremely immature, truly infantile in its appearance, with scarcely a sign of the variety of features that will be developed in its later history. Does not this consideration lend additional interest to the study of so simple and monotonous a district as the plain of the Red River of the North? Is there not a keener appreciation of its peculiarities gained by looking at them in the light of their development, instead of describing them simply as absolute forms, not otherwise considered.

The Red River plain has, however, begun its development. The Red River itself has incised a narrow, steep-sided trench twenty or forty feet deep in the surface of the plain, and the few side branches of the river have narrower and shallower channels. These trenches and channels are simply young valleys, and they are growing so rapidly that their increase in length and width is noticeable even in the past few years of settlement. But still the streams have barely made a beginning of the great work of carrying away all the material of the plain above base-level, this being their manifest future task. So little has been done as yet in the way of preparing drainage-channels that the rain which falls here is greatly delayed in reaching a stream-course by which

it may flow to its goal, the sea, and so much of it stands about idly, instead of quickly running off, that it is in good part evaporated and carried away through the air. Evidently we have here to do with a geographic individual that is just entering its career, that still retains its embryonic characteristics, so little has it advanced in its life-history.

Can we not foretell something of the future history of this plain? As the rivers carve their trenches deeper and deeper, and the enclosing slopes are wasted away and widen out, and the little side-gullies eat backwards and increase in length till they become ravines and the ravines grow into valleys, then the inter-stream surface, at first smooth and unbroken, is traversed in all directions by branching water-courses; the rainfall is much more quickly led into the streams,—everything marks a more advanced stage, all of whose features are indicated in one of the models of the plain and plateau series. But we can not only predict the future of the Red River plains; we can find examples of other plains, born at an earlier time, that are now in the advanced stage that the Red River plains have yet to reach. Look at the coastal plains of the Carolinas. They are the old bottom of the Atlantic, laid bare by a relative uplift of continent. They are well drained; many streams run across them and many branches give ready discharge to the rainfall; the channels are deeper below the general level of the country than are those of the Red River plains, and the inter-stream surface is much more broken; yet still enough of it remains to make it clear the present form is developed from an originally level, unbroken plain; and a close comparison will leave no doubt that the coastal plains of the Carolinas differ from the Red River plains chiefly in being farther advanced in their cycle of development. They are closely related individuals, but they differ somewhat in age. They are like the egg of a caterpillar and the caterpillar itself; not very similar at first, and not like what they will come to be later on, but closely comparable for all that; their differences only manifest their relationship; what one is, the other will be; what the other is the first has been. Thus we can introduce into geography the element of growth, that is, systematic change,

and greatly to the enlivenment of the study. It is often the reproach of geography that it does not deal with things having life; but this is true only if we do not take heed of the kind of life that it may consider. One may say that the changes here discussed are so slow that we need not take account of them; but this is predetermining what we shall and what we shall not study; let us rather see if the consideration of slow geographic life does not impart new meaning to an old study; let us question if this new meaning is not nearer the truth that we are striving for; then we shall be better in a position to judge if slowness of change is a reason for its neglect. No one makes objection to teaching a young scholar about the growth of an oak tree from an acorn, though it is safe to say that no scholar comes to the belief of the growth of an oak from witnessing it; he is convinced of a change that he cannot wait to see, partly by comparison with trees of a faster growth, and partly by seeing oaks of different sizes, and being led to make reasonable generalizations on his observations. It is the same with our understanding of geographic growth; we cannot see much of it, not even the oldest of us, and yet, after the conception is once gained, it becomes so vivid that one can hardly help expecting to find that a change is perceptible on returning after a time to some familiar locality. One may see a sand-bank washed away by a heavy rain, and from this to the washing down of the largest mountain there is only a difference of degree, not of kind. A scholar may easily comprehend the change of form indicated by the differences between the two plains already described, and unless his natural intelligence is obstructed, he can then grasp the idea of geographic growth.

Let us next look at West Virginia, typified in the second model of the series; here the inter-stream hills are so high that they almost merit the name of mountains; the stream branches have become so numerous that no part of the original level upland surface remains; every part has an immediate slope to a stream, and the drainage system is advanced to its highest development. Indeed, we need some aid here from geology to be sure that we are dealing with an individual of the same kind as those already considered, so little likeness is there between this

one and the others. But the aid from geology is conclusive; for West Virginia and a large area around it is made up of horizontal layers of bedded rocks that once were at the bottom of the sea, and that still retain the essentially horizontal attitude in which they were laid down: the whole mass of horizontal layers has simply been raised with respect to the surface of its parent ocean.[1] This elevation is so long ago that the immaturity such as still characterizes the Red River plains is here long past; the adolescence seen in the Carolina plains is also long ago lived through. In West Virginia we have maturity; there can be no greater variety of form than is here presented. The relief of the surface is at its highest value, for while the inter-stream hills have not lost much of their original height, the valleys have been sunk about as low as they can be, and hence there is the greatest possible difference of altitude between hill-top and valley-bottom. The streams have become very numerous, and can hardly be more so; every part of the surface is intersected by them. There is no room for more.

From this time on the form of the surface becomes less pronounced. As the destructive changes progress further, the valleys can deepen but little, although the hill-tops must be reduced, and the valley-slopes must widen out, and all the topographic expression must weaken as old age is approached. This is the character of central Kentucky, and appears in the third model of the set. Excepting where the valleys are enclosed in especially hard rocks, they are wide open, and the variable height of the intervening hills makes it clear that they retain no longer all of the height that they once possessed. They are weakening, passing into forms of less and less emphasis, losing variety, becoming old and feeble.

In the next stage, we may expect to find the valleys so far widened that they should form broad plains, smoothly rolling, essentially a low-land of faint relief, but occasionally diversified

[1] In speaking here of relative changes of level between land and sea, I do not wish to raise the question as to how the level was changed; except to say that the teachings of Suess and Penck in this matter seem to me to go too far in excluding unknown possibilities of broad changes of level, without folding, in the crust of the earth, and without local changes of gravity, on which these authors depend.

with hills of moderate height; and thus the very opposite of the Caroline plains, where the surface is an upland, with occasional valleys. Such an old plain may be seen about the head-waters of the Missouri, in eastern Montana; the general surface is extremely monotonous, gently rolling, and one roll like the next, so that one may easily lose his way in the absence of landmarks. But here and there over the plain mesas of considerable elevation still remain, the reason for their endurance being seen in the layer of hard lava that protects them, and retards their destruction, while the rest of the country not thus protected has wasted away more rapidly. These lava-caps are old flows from once active volcanoes; the lava at the time of eruption undoubtedly ran down from its vents to the lowest ground that it could find; and yet it now occupies the highest ground, in virtue of its obstinate refusal to waste away. Every such lava-cap is an outspoken witness to the greater mass of material over the whole country when the eruption took place, and the destruction of this greater mass must have progressed through the several stages illustrated by the present condition of the Red River plains, the Carolina plains, the mountains of West Virginia, and the hills of central Kentucky, before it could have reached a surface of faint relief. It requires great faith in the evidence here adduced to believe that so stupendous a piece of work has really been accomplished. It is well nigh incredible, and the observer on the ground is fully justified in doubting it as long as he can; but it cannot be doubted when the evidence is once well seized. It is by no means unparalleled, and much nearer home we may find examples as extraordinary, and as far from easy belief, but as necessary to the convictions of the well-ordered geographer.

Such a plain as that of the upper Missouri may be called a base-level plain, because it has been worn down to the controlling level of drainage, or to what is called the base-level of the region; this being in distinction to a constructional or new plain, whose smoothness is due to the short time that its original form has been exposed to developing agencies. A base-level plain represents the ultimate stage in the sequence of a simple cycle of development.

Certain elements of importance yet remain to be considered. If the plain be raised to a moderate height over sea-level, it can never acquire great intensity of relief; for the streams are then allowed but a small depth to which they can cut. If, on the other hand, the elevation is great, and rapid enough to be for the most part acquired before the destructive processes have made great headway, then the vertical element is strong, the topographic relief is intense. Our coastal plain is an example of a region of mild form; it has but slight elevation, and hence however long the rivers flow across it they can never cut out deep valleys. The plateaus of Utah and adjacent parts of the west are of another sort; here the elevation is excessive, and the depth of cutting allowed to the rivers is correspondingly great. Marvelously have they taken advantage of their opportuity. The valley cut by the Colorado and its tributaries is in some places a mile deep, and yet, when we see the enormous mass of land still lying on either side of the valley above base-level, and waiting to be carried down to the ocean, we cannot doubt that the time thus far employed in doing so great a piece of work is a small part of the whole cycle of growth. The upper plateau surface is still broadly level, except for certain irregularities to be referred to later on; the valley is narrow even to notoriety, and must therefore be called young. It is a case of precocious adolescence. Intensity or faintness of relief are therefore variations on the general scheme, and it is my intention that these variations shall also be represented by models when new members are added to complete the present series: a young plateau of intense relief, a middle-aged plain of mild relief, will thus become definitely intelligible terms to our mind. Along with this, it must be perceived that two mature plains need not be of the same age, if measured in years: for the development of maturity in a high plateau requires more time than in a lowland.

There is another element of variation that must be considered. Sometimes the simple cycle of development that has been described is interrupted: the land does not lie quiet long enough to pass through a complete series of changes without disturbance. Indeed, this interruption is, except in very young plains, the

PLATE XXII.

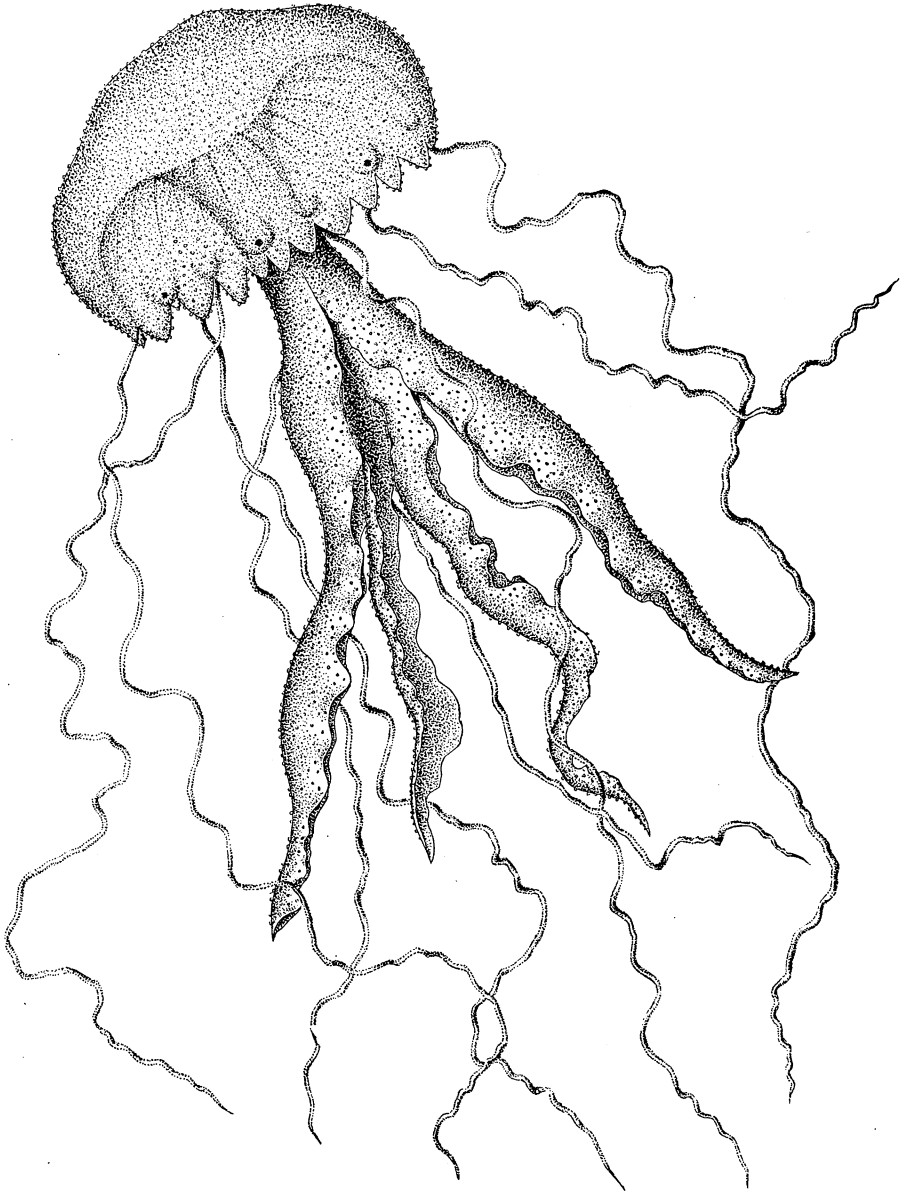

FIG. 1.—*Pelagia panopyra.*

rule and not the exception; and several of the examples already given illustrate it. The coastal plain of the Carolinas has suffered a moderate depression since its valleys were defined pretty much in their present form, and their lower courses are thereby slightly submerged. Thus arise the estuaries that characterize our Atlantic coast, and these are presented in the fourth model. The old base-level plain of the upper Missouri no longer stands at the low level in which it was worn down, but has been elevated a thousand feet or more, and hence all its rivers that had settled down to a quiet old age of little work, have been rejuvenated, and are now beginning a second cycle of life. They run swiftly, in well-defined, narrow valleys, even though the enclosing rocks are soft; and they are sometimes interrupted by waterfalls, even when their volume is as large as that of the Missouri above Fort Benton. Manifestly, therefore, the elevation of the old plain is relatively recent; very little advance has yet been made in the development of its second cycle. The same kind of complexity appears in the high plateaus of Utah and Colorado: the high-level surface in which the cañons are cut is not an original surface of construction, but is a surface of considerable irregularity, as has already been mentioned; part of the irregularity is due to great fractures which have broken the country into massive blocks and lifted them a little unevenly, and part is due to the incomplete base leveling of the region during a previous cycle of development, when the elevation was less than now. The combination of old and new forms thus explained is the subject of the fifth model. A wonderful addition is made to our appreciation of a country when all these factors in its history are recognized as contributing essentially to its topography.

Is it not worth while to try to acquire the broader comprehension of geography that comes from understanding its meaning? Can we not make immediate practical use of such terms as infantile, young, adolescent, mature or middle-aged, old, and very old? Do they not recall all the significance of certain selected or idealized typical examples that have been studied, being in this like the terms that the botanist employs to so great advantage? No botanist would admit the superiority of paraphrases over

terms; compactness, accuracy, and intelligibility would all be sacrificed if terms were given up. And yet nearly all geographers employ paraphrases instead of terms. Let us take an example to illustrate this from the description of certain counties in Missouri in one of the geological reports on that state, to which as in other states we must generally go for the best geographic materials.

The region is one of horizontal structure, and therefore comes under the general heading now considered. Of Miller county it is said: [1] "Near the Osage and its larger tributaries, the country is generally very broken and rocky, excepting immediately in the valleys; but farther back the slopes usually become more gentle, with fewer exposures of rock, until we reach the higher districts, more remote from the streams, where the surface is comparatively level, or but slightly undulating." Again, of Morgan county: "The surface of the elevated region near the middle of the county is beautiful, comparatively level or undulating prairie land. South of this the slopes are first gentle, near the head branches of the Gravois, but as we descend these the face of the country becomes more hilly, and almost everywhere near that and the main creeks, as well as their principal tributaries, and especially near the Osage, it is very broken and rocky. North of the main divide, the high, nearly level prairie land extends, with a slight descent, for some distance northward between the streams flowing in that direction, but near most of the larger streams the surface is more or less broken, and sometimes rocky, but generally not so much so as on the south side."

What is meant by this? Manifestly, the country is an adolescent plain of moderate intensity of development and apparently of simple history. The horizontal attitude of the rocks and the level surface of the uplands show us that the region belongs to the family of plains or plateaus; the irregular courses of the streams and the steepness of their banks decide with equal clearness that the development of the plain has not advanced very far.

Now in the same report the writer says that there are oak trees

[1] Reports on the Geological Survey of the State of Missouri, 1855–1871, (1873); the above extracts being from county reports by Meek, pp. 112, 135, 136.

in the forests. Why does he not say that there are tall vegetable growths, of irregular bifurcations, bearing green appendages at the attenuated extremities, these appendages being strongly scalloped in outline, and so on. He also speaks of pines. Why not of other vegetable growths, with straight vertical axes, from which lateral arms spread out with some regularity, bearing long slender spicules on their minuter divisions. Instead of this, he says oak and pine. This is not because all oaks and all pines are of precisely one pattern. Their variations are infinite, but for all that they vary only througn a moderate range, and can all be brought under typical forms. They may be young or old, large or small, well grown or deformed, living or dead, but they are still oaks or pines. How well it is, therefore, that they should be known by a definite term or name. How well it would be if geographic forms were equally well named; and why should they not be? The many plains that we have described do not differ more greatly among themselves than the oaks or the pines; they deserve recognition as constituting a family, naturally related, not by inheritance from descent, as with the trees, but by similarity of the physical processes under which they have been developed. The natural association of their features deserves just such recognition as is implied by giving them names, distinctive and well defined.

Do we not gain a better understanding of the earth's surface, of the primary object of geographical study, by thus looking at the meaning of land form, as well as at the form itself? Is not the possibility of accurate description greatly increased thereby, and does not the description when made carry more of the desired meaning than ordinary geographical narration, in which there is no definite standard recognized for comparison? The reason of this is not far to seek. Our conception of the unknown is based on the conception of the known, either by likeness or contrast. Ordinary geographic description has not sufficient accuracy, because its terms are vague; they do not bring up to the mind the recollection of any well-defined type or standard. Plain, rolling country, hilly country, broken country, have no precise meaning; they "denote" but do not "connote." But when we examine a series of geographic forms related by community of

structure, though contrasted in age, and give to every one a name, such as a young plain, a mature or middle-aged plain, these terms bring certain well-marked conceptions before us, conceptions that have been elaborated in our study of the type or standard of reference, and we readily form a mental picture in which all the many essential features of the region described are clearly appreciated. An adolescent plain, for example, is a surface of broad even uplands, here and there trenched across by streams which follow valleys of moderate width; the general continuity of level from one inter-stream surface to another comes to mind; the relative scarcity of the smaller stream channels; the relation of the region to its fellows of greater or less age.

It is immaterial what names are used for the present in describing plains and plateaus, for none as yet are authoritatively accepted by geographers, but it would be to our common advantage if experiment were made on the use of a larger set of terms than is now commonly employed. The important point is that terms based on natural relationship should be used, and that they should be familiarized by the study of type forms. Experiment will alone decide what term shall be finally adopted. My own experience with students of undergraduate age has shown me that the idea as here outlined is a valuable one, and that the terms here employed are suggestive and satisfactory. I am very desirous of hearing the experience of others in the same experimental line.

A few words may be said as to the method of using the models, a method that seems to me adapted to young as well as to more advanced scholars. A series of models is laid out on the tables of a room which, in the schools of the future, may, I trust, be called the geographic laboratory. The students are seated near them, and each one is asked to describe what he sees; to note if he can recognize any features of the miniature landscape that are already familiar to him from his own observation. He is then told to try to draw a map of the surface represented, or a part of it if the whole is somewhat complicated. More or less aid must be give here, as so many students are untrained in the simplest delineation. When the map is drawn, show the

class a map of some actual region of the same kind as that typified in the model; ask them to notice how far the features that they have drawn from the model are features on the actual map; let them search for additional features, generally small ones that may appear on the map, but which are not shown on the model.

Next produce the second model, and go through the same process, but without any suggestion that the first and second models are related. Finally, ask if any one perceives a connection or relation between the two regions thus considered. Few can fail to see it, and when perceived it should be described by every member of the class for himself. I have great faith in the scholar's own careful expression, both in drawing and in writing, of what he has himself seen or thought. Note here that the scholar need not discover how the change from one form to the next has been produced, he need only recognize it; then the teacher may supplement the recognition as far as he wishes with simple geological explanation of processes. This need not go far, and merely opens the way to further study of geology. The word geology need not be mentioned.

If the class be somewhat mature, the teacher may, before bringing out the third model, ask for predictions of the form of the future stages of the region; or, if this seem venturesome, the simpler inductive method may be still followed. At last the models showing complications and interruptions in a single cycle of change may be introduced, all the examples being illustrated by maps of actual relations, as well as by models, views, descriptions, and in every other way that the ingenuity of the teacher devises.

When thus familiarized with the general conception of geographic change, let the scholars attempt to make full statement of all they have learned from the work so far concerning geographical relationships. The brighter ones will here manifest some perception of the generalizations that may be based on the facts thus far presented, and from this time on geographic form has a new and a fuller meaning to them. Additional examples of the various stages of development may be introduced at the discretion of the teacher; and if time allow they can be best taken from books

of travel and exploration, reports of state and government surveys, and the like, in order to give some freshness and reality to the study. It is apparent enough that, in its fully expanded form, it will take a long time for the better geographical teaching to enter the larger public schools, but in schools where teachers are numerous enough to give every scholar a good share of personal attention, I do not despair of seeing geographical laboratories and a rational inductive method of instruction employed.

Comparisons have already been made between the methods employed in teaching biology some forty or fifty years ago and during the last decade. It seems to me that physical geography is still in the undeveloped condition that biology has outgrown. Our text-books of physical geography attempt to describe the whole earth, just as the old natural histories tried to describe the whole animal and vegetable kingdoms. Since the publication of Huxley and Martin's Biology, this plan has been abandoned in the better schools, and the pupil now studies the few typical forms that give him a knowledge of the great resemblances of animals, and does not dwell on their minute differences. He learns a good deal about a few animals instead of a very little about a great many. I should like to see the same change introduced into the teaching of physical geography. It is impossible for a scholar to learn anything definite about the form of the earth's surface if he attempts to study all the continents. He might as well attempt to learn about the distribution of forests instead of studying the structure of plants in his botany lessons. Something of the grosser continental forms should of course be considered, just as it is interesting to know something of the distribution of forested and of desert region; the general distribution of land and water, its relation to climate, history, and so on,—all this is of great interest; so are the generalizations concerning evolution and the speculations concerning migrations in which the biologist may indulge, but they do not form the chief matter of our best elementary methods, for they cannot be sufficiently original with the ordinary student. When a boy grows up and travels over the country, he never sees the grosser continental forms; they are too large. He sees only small forms, corresponding to the indi-

vidual plants of the forest. Why not then instruct him in such a way that he shall appreciate these small forms, these geographic individuals, just as he is taught to understand something of botanical individuals? Let him understand that there is a geographic morphology, perhaps not so precise as that of the organic world, but none the less interesting; let him feel that these geographic forms are the results of definite orderly processes, working systematically, and carrying the geographic individual through a determinate sequence of changes, nearly as definite as that passed through by any animal or plant in its life-development, but more complicated from the combination of the records of several cycles of life often being found in one individual. Let him learn that every feature of a geographical individual is significant and expressive, full of meaning to those who look at it aright. Do not hesitate to call on geologic processes when they are needed to aid his understanding; do not postpone the few necessary and simple geological conceptions until he reaches a geological course of study. Do not be discouraged because the earth's surface contains many complicated individuals; there are many simple ones also, which a student may appreciate and enjoy, and from which, when thus understood, he may form a juster idea of unseen regions. Of course there are many complicated forms that he will not easily comprehend; but so there are plants of difficult analysis, yet this is not held to be an excuse for giving up the teaching of systematic botany. Few scholars may be able to analyze all the compositæ, or to recognize all the species of oaks, even if they have learned their lessons well in school, and yet we do not doubt that there is profit in the teaching of systematic botany. So there may be in teaching the elements of systematic geography. Let the scholar learn a few simple forms well, as he surely can without difficulty; he will recognize these when he sees them, and, finding meaning in their form, he will be convinced that there is meaning also in the more complicated forms that his slight study has not deciphered. He may even come to conceive that he has not "finished" geography, and that it is capable of advanced study for its own sake.

Cambridge, Mass., February, 1889.